

WE CLAIM:

1. A disk drive comprising:

- (a) a disk comprising a plurality of tracks, wherein each track comprises a plurality of data sectors and a plurality of servo wedges;
- (b) a head actuated over the disk;
- (c) a spindle motor for rotating the disk at an operating speed in response to a spindle control current, the spindle motor comprising a plurality of windings which generate a back electromotive force (BEMF) voltage;
- (d) a BEMF detector for generating a BEMF signal by comparing the BEMF voltage to a threshold;
- (e) a current modulator for generating a PWM signal representing the spindle control current;
- (f) BEMF detection window circuitry for periodically disabling the PWM signal for a predetermined interval to attenuate noise in the BEMF voltage while the BEMF detector compares the BEMF voltage to the threshold; and
- (g) a disk controller for:
 - measuring a BEMF speed error responsive to the BEMF signal during a BEMF spindle speed control mode;
 - updating the spindle control current in response to the BEMF speed error to drive the disk at the operating speed;
 - disabling the BEMF detection window circuitry to reduce acoustic noise and switching to a wedge spindle speed control mode;
 - measuring a wedge speed error in response to the servo wedges;
 - maintaining the disk at the operating speed by updating the spindle control current in response to the wedge speed error;
 - if an error condition is detected, enabling the BEMF detection window circuitry and

26 maintaining the disk at the operating speed by updating the spindle control current
27 in response to the BEMF speed error generated from the BEMF signal; and
28 when the error condition subsides, disabling the BEMF detection window circuitry
29 and maintaining the disk at the operating speed by updating the spindle control
30 current in response to the wedge speed error generated from the servo wedges.

1 2. The disk drive as recited in claim 1, wherein the error condition occurs if the spindle
2 control current is not updated within a predetermined interval.

1 3. The disk drive as recited in claim 2, wherein the spindle control current is not updated if a
2 servo wedge error is detected.

1 4. The disk drive as recited in claim 3, wherein the servo wedge error includes an inability
2 to synchronize to a servo wedge.

1 5. The disk drive as recited in claim 3, wherein the servo wedge error includes detecting an
2 invalid track identification value in servo wedge.

1 6. The disk drive as recited in claim 1, further comprising a commutation sequencer for
2 energizing the windings in a predetermined commutation sequence, wherein:
3 (a) the commutation sequencer is clocked in response to the BEMF signal while the
4 BEMF detection window circuitry is enabled; and
5 (b) the commutation sequencer is clocked at a fixed frequency while the BEMF detection
6 window circuitry is disabled.

1 7. The disk drive as recited in claim 6, further comprising a phase-locked-loop (PLL) for
2 generating a commutation clock for clocking the commutation sequencer, wherein:

- 3 (a) the PLL locks a frequency of the commutation clock to a frequency of the threshold
4 crossings in the BEMF signal while the BEMF detection window circuitry is enabled;
5 and
6 (b) the PLL holds the commutation clock at a fixed frequency while the BEMF detection
7 window circuitry is disabled.

1 8. The disk drive as recited in claim 1, further comprising a commutation sequencer for
2 energizing the windings in a predetermined commutation sequence, wherein the
3 commutation sequencer is clocked in response to the BEMF signal while the BEMF
4 detection window circuitry is enabled and while the BEMF detection window circuitry is
5 disabled.

1 9. The disk drive as recited in claim 1, wherein after the error condition is detected the disk
2 controller waits a predetermined interval for the BEMF speed error to settle before
3 updating the spindle control current in response to the BEMF speed error.

10. A method of operating a disk drive, the disk drive comprising a disk comprising a plurality of tracks, wherein each track comprises a plurality of data sectors and a plurality of servo wedges, a head actuated over the disk, a spindle motor for rotating the disk at an operating speed in response to a spindle control current, the spindle motor comprising a plurality of windings which generate a back electromotive force (BEMF) voltage, a BEMF detector for generating a BEMF signal by comparing the BEMF voltage to a threshold, a current modulator for generating a PWM signal representing the spindle control current, and BEMF detection window circuitry for periodically disabling the PWM signal for a predetermined interval to attenuate noise in the BEMF voltage while the BEMF detector compares the BEMF voltage to the threshold, the method comprising the steps of:

- (a) measuring a BEMF speed error responsive to the BEMF signal during a BEMF spindle speed control mode;
- (b) updating the spindle control current in response to the BEMF speed error to drive the disk at the operating speed;
- (c) disabling the BEMF detection window circuitry to reduce acoustic noise and switching to a wedge spindle speed control mode;
- (d) measuring a wedge speed error in response to the servo wedges;
- (e) maintaining the disk at the operating speed by updating the spindle control current in response to the wedge speed error;
- (f) if an error condition is detected, enabling the BEMF detection window circuitry and maintaining the disk at the operating speed by updating the spindle control current in response to the BEMF speed error generated from the BEMF signal; and
- (g) when the error condition subsides, disabling the BEMF detection window circuitry and maintaining the disk at the operating speed by updating the spindle control current in response to the wedge speed error generated from the servo wedges.

- 1 11. The method as recited in claim 10, wherein the error condition occurs if the spindle
2 control current is not updated within a predetermined interval.
- 1 12. The method as recited in claim 11, wherein the spindle control current is not updated if a
2 servo wedge error is detected.
- 1 13. The method as recited in claim 12, wherein the servo wedge error includes an inability to
2 synchronize to a servo wedge.
- 1 14. The method as recited in claim 12, wherein the servo wedge error includes detecting an
2 invalid track identification value in a servo wedge.
- 1 15. The method as recited in claim 10, further comprising the step of energizing the windings
2 in a predetermined commutation sequence at a commutation frequency, wherein:
3 (a) the commutation frequency is generated in response to the BEMF signal while the
4 BEMF detection window circuitry is enabled; and
5 (b) the commutation frequency is a fixed frequency while the BEMF detection window
6 circuitry is disabled.
- 1 16. The method as recited in claim 10, further comprising the step of energizing the windings
2 in a predetermined commutation sequence at a commutation frequency, wherein the
3 commutation frequency is generated in response to the BEMF signal while the BEMF
4 detection window circuitry is enabled and while the BEMF detection window circuitry is
5 disabled.

- 1 17. The method as recited in claim 10, wherein after the error condition is detected further
2 comprising the step of waiting a predetermined interval for the BEMF speed error to
3 settle before updating the spindle control current in response to the BEMF speed error.